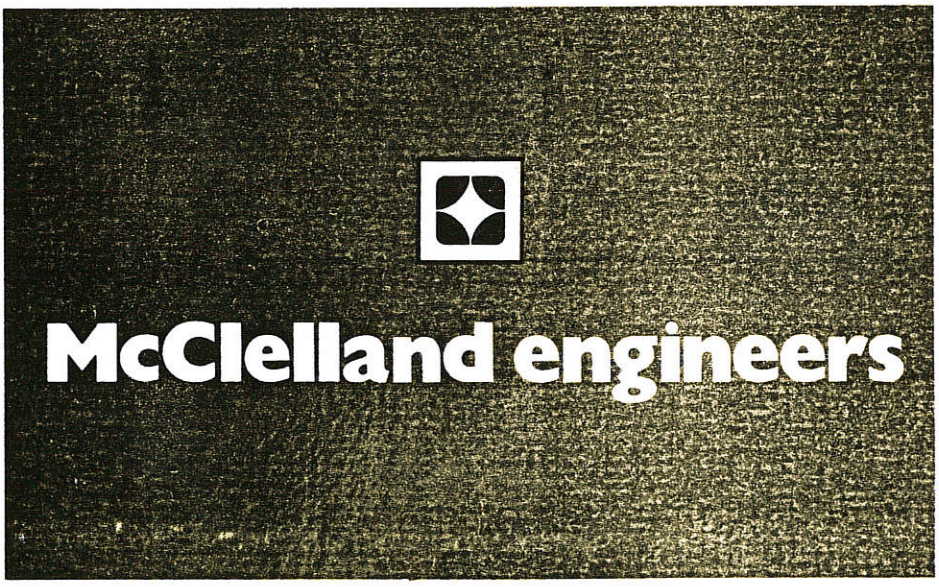
VOLUME I

# GEOTECHNICAL DATA REPORT
# OVERVIEW OF ISLAND STUDY
# ISLES DERNIERES STABILIZATION PROJECT
# STATE PROJECT NO. 750-55-01
# TERREBONNE PARISH, LOUISIANA

REPORT TO

J. WAYNE PLAISANCE, INC./T. BAKER SMITH & SON, INC.
HOUMA, LOUISIANA



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R e p o r t

t o

J. WAYNE PLAISANCE, INC./T. BAKER SMITH & SON, INC.

Houma, Louisiana

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M c C L E L L A N D  E N G I N E E R S,  I N C.
Geoscience Consultants
Westlake, Louisiana

December 1987

# McClelland engineers

Report No. 1087-1328
Volume I
December 23, 1987

J. WAYNE PLAISANCE, INC./T. BAKER SMITH & SON, INC.
550 South Van
Houma, Louisiana 70361

Attention: Mr. Marc Rogers, P.E., Project Manager

Geotechnical Data Report
Overview of Island Study
Isles Dernieres Stabilization Project
State Project No. 750-55-01
Terrebonne Parish, Louisiana

Mr. Rogers, we are pleased to submit Volume I, of a three-volume report, for the geotechnical services performed for the proposed Isles Dernieres Beach Stabilization Project. This work was authorized in writing by Mr. Rogers on April 7, 1987, and our services were performed in general accordance with the signed agreement dated February 16, 1987. During the project, minor changes to the scope of work and method of data presentation were made in order to address the concerns of the design professionals involved with this project and as a result of the encountered soil conditions.

Volume I discusses our field investigation procedures, describes the laboratory testing procedures, and explains our method of data presentation for the three island segments. Volume II, submitted under separate cover, describes the laboratory testing procedures and explains our method of data presentation for the proposed borrow areas. Volume III is our Geotechnical Interpretive Report and it presents the results of our geotechnical engineering studies for the proposed stabilization program. This document will also be submitted as a separate document. At various times during this project, we provided preliminary findings to the design team members. The information in the above referenced reports supersedes and replaces all previous data.

Mr. Rogers, we appreciate the opportunity to be of service to you and the design team on this initial phase of this very important study. We look forward to working with you on later phases of the study. After you receive this report, we will call you to answer your questions.

Sincerely,
McCLELLAND ENGINEERS, INC.

Andrew L. Shafer
Project Engineer

David E. Lourie, P.E.
Division Manager

ALS/DEL/me(R14.30)
Copies Submitted: (6)

# CONTENTS

## EXECUTIVE SUMMARY

A reconnaissance study was performed to explore the subsurface conditions for the three-island segments of Isles Dernieres. This effort was undertaken as part of a comprehensive study for the proposed beach stabilization project for these islands. The results of our study are presented in three volumes. Volume I, Overview of Island Study, is presented here. This volume contains a complete description of the field and laboratory procedures. It also includes an overall plan of the islands showing the cone locations. Volumes Ia through Ic which are submitted under separate cover, contain field and laboratory data. Volume II contains information from the proposed borrow areas. Volume III, the Geotechnical Interpretive Report, also presented under separate cover, provides geotechnical recommendations for preliminary design of the beach restoration program.

The purpose of this study was to develop site-specific preliminary geotechnical information on the island segments and in the proposed borrow areas north of the islands. It should be recognized that while significant portions of the design concepts can be finalized using the information presented here, optimization of design alternatives requires additional study. To accomplish the purpose of this study, a total of 180 cone penetrometer soundings were performed that totalled more than 3300 lin ft. The soundings ranged in depth from 10 to 43 ft and were usually located about 1500 ft on center. At most locations along the range lines, three soundings were conducted. In general, one was performed along the south side of the island, one near the middle of the island, and one on the north side of the island. The cone penetrometer data were reduced using our in-house computer program that is based on well-established cone penetrometer correlations.

At each cone location, bag samples of the surficial soils were obtained to determine their engineering properties and to aid in soil classification. Soil testing consisted of mechanical grain size analysis, liquid and plastic limit tests, water contents, and remolded miniature vane tests.

This data report discusses our methods of operation and data presentation for the cone penetrometer traces, cone penetrometer data interpretation, and laboratory test results.

# INTRODUCTION

## Background

The Isles Dernieres is a low profile barrier island chain located along the Gulf Coast of Louisiana in Terrebonne Parish. The islands are about 4 to 6.5 mi south of the mainland and are separated from the mainland by lakes and bays. Currently, the island chain is relatively undeveloped and consists of three island segments: East Island, Middle Island, and West Island. These three island segments contain about 16 mi of coastline along the Gulf side, and the width of the islands varies between about 200 and 5000 ft. The islands are separated from each other by breaches and passes. Plan views of the islands are shown in the Illustrations section of this report.

Reportedly, the entire island system is both migrating landward and eroding. Historical records indicate that in the mid-1800s the islands were separated from the mainland by only a quarter of a mile. The islands were also less fragmented and had a greater area. Currently, the island area is less than about one third of the area believed to present in the late 1800s. Since about 1850, Lake Pelto has increased significantly in size due to a number of factors including relative sea level rise and subsidence. It is estimated that the islands have migrated landward by about 0.6 mi since the mid-1800s. Furthermore, Isles Dernieres is estimated to be retreating at a rate of 30 to 90 ft per year. Although erosion is occurring due to a number of factors, erosion of the islands is caused primarily by hurricanes. The information presented here concerning the background of Isles Dernieres was provided by The Traverse Group during this study.

## Project Description

In response to concerns about the loss of Isles Dernieres, a comprehensive study has been undertaken for a proposed beach stabilization project. The proposed beach stabilization project conceptually consists of nourishing the islands using dredged materials obtained from north of the islands. Other aspects of the project may include the construction of coastal structures.

During the course of this project, we have communicated with various members of the project team through meetings, phone conversations, and

written correspondence. This interaction has been with representatives from T. Baker Smith & Son, Inc.; The Traverse Group, Inc.; and Ocean Surveys, Inc. We have also discussed key aspects of our field and laboratory programs with the Louisiana Department of Transportation and Development. Furthermore, we have supplied unused portions of the vibracore samples to the Louisiana Geological Survey and Louisiana State University.

## Purposes and Scope of Services

In order to identify and select appropriate beach stabilization alternatives within the framework of the concepts planned for Isles Dernieres, it was necessary to investigate subsurface conditions on the islands and in the proposed borrow areas. The purposes of our involvement on the islands were to:

- Develop site-specific information on subsurface conditions on the islands,
- Evaluate the data collected, and
- Provide preliminary geotechnical design recommendations for the proposed beach stabilization project.

To accomplish these purposes, the components of the reconnaissance study on the islands included the following:

- Modifying and mounting our specially developed cone penetrometer for use on an all-terrain vehicle,
- Conducting shallow cone penetrometer soundings at locations specified by T. Baker Smith & Son, Inc., on the three islands,
- Obtaining bag samples of the surficial soils at each cone sounding location,
- Interpreting the cone data using well-established correlations with the aid of our in-house computer program,
- Performing laboratory tests on recovered soil samples to determine classification, water content, and remolded shear strength of the surficial soils,
- Summarizing the data collected and preparing Geotechnical Data Reports presenting the results of the field exploration and laboratory testing programs,
- Analyzing the field and laboratory data, and developing preliminary recommendations to guide planning and construction of beach stabilization concepts, and
- Preparing a Geotechnical Interpretive Report presenting our evaluation of the data, results of our engineering analyses, and the recommendations we developed.

## Relevant McClelland Reports

In 1959, McClelland Engineers conducted a subsurface investigation for the State of Louisiana Department of Public Works as part of a beach erosion control study from Belle Pass to Raccoon Point. As part of that study, a total of five borings penetrating from 20 to 50 ft were drilled and sampled on Isles Dernieres. The results of that study are presented in McClelland Engineers Report No. N5905, dated January 13, 1960.

The data and recommendations developed during this reconnaissance study are presented in three volumes for the islands and the borrow areas and are reported as follows:

- Volume I consists of Volumes I, Ia, Ib, and Ic. Volume I is presented here and provides an overview of our methods and procedures for our field and laboratory investigations on the islands. Volumes Ia through Ic contain field and laboratory data from the East, Middle, and West Islands, respectively.
- Volume II consists of Volumes II, IIa, IIb, and IIc. These volumes discuss our involvement and present data from the proposed borrow areas.
- Volume III is the Geotechnical Interpretive Report and it contains the results of our engineering analyses.

## Report Format

The field exploration and laboratory testing programs are described within the text of this report. Illustrations follow the text and complete Volume I.

# SUBSURFACE EXPLORATION PROGRAM

## General

In mid-April 1987, preparations began for modifying our cone penetrometer unit for use on an all-terrain amphibious Rolligon Model 4450 vehicle that had wide flotation tires and ground contact pressures less than 2.5 psi. On April 29, field operations began on the East Island using a three-man crew. After about one week, the crew size was decreased to two, an engineer and an electrical-mechanical technician. Work generally progressed in a westward direction and on-island operations were completed on May 12, 1987.

In general, cone penetrometer sounding locations were selected based on the project plan of three soundings on each range line; modifications to

this, plan occurred as a result of access conditions and island size. At some locations, especially on the north side of the islands, mangroves limited access and caused flat tires on the Rolligon. In some areas, the islands were so narrow that three soundings per range line was impractical. Initially, range lines were intended to be about 1500 ft apart, but on the West Island the spacing was decreased to about 700 ft because of the decrease in island size and the goal of obtaining the specified number of cone soundings. Surveying of the range lines and cone penetrometer test (CPT) locations was performed by T. Baker Smith & Son, Inc.

## Cone Penetrometer Tests

**Numbers, Locations, and Depths.** A total of 180 CPTs ranging in depth from 10 to 43 ft and totaling about 3330 lin ft were performed on the three islands. Plan views of islands showing the CPT locations are provided in the Illustrations section of this report. Tabulated below are details of the numbers and depths of the CPTs for each island.

| Island Designation | Number of CPTs | Depth Range, ft |
|---|---|---|
| East Island | 91 | 10 to 31 |
| Middle Island | 42 | 16 to 43 |
| West Island | 47 | 10 to 22 |

As noted above, details of the individual CPTs are presented in Volumes Ia through Ic. At each cone location, our field engineer obtained a bag sample of the near-surface soils for laboratory testing.

**Equipment Description.** Static cone penetration testing was performed using McClelland Engineers' mobile electric cone penetrometer unit, the Unicorn System (patent pending). This unit consists of an instrumented penetrometer tip and sleeve which is pushed into the ground by means of push rods and a hydraulic ram. For this project, the equipment was mounted to an all-terrain vehicle. The dead weight of the equipment and vehicle serves as a reaction to the force required to push the cone penetrometer into the ground.

The tip resistance against penetration exhibited by the soil is called the cone resistance (q). This resistance is measured on a conical tip which has an apex angle of 60 degrees and a base area of 1.27 $cm^2$. The tip is pushed into the ground at a constant rate, 2 cm per second. Local side friction resistance (f) is measured on a 25.4 $cm^2$ cylindrical sleeve located immediately above the tip. Penetration resistance components, q and f, are

continuously measured by strain gauge load cells built into the tip. Signals from these cells are transmitted by electrical cables through the hollow push rods and are digitized and recorded on floppy disks. These signals are also displayed on an on-board video monitor.

Data Presentation. The data from our CPTs are presented in Volumes Ia through Ic. The data include the individual CPT traces and data interpretation. The CPT traces contain plots of point resistance, q, sleeve friction, f, and friction ratio percent, f/q. The data are presented for every 0.2 ft of penetration below 0.6 ft to the completion depth.

To obtain geotechnical engineering parameters requires interpretation of the cone data. Typically, this is performed through the use of generally accepted, well-established correlations that are supplemented by site-specific field and laboratory data obtained from borings. Sample borings were beyond the scope of this investigation, so our data interpretation relies on correlations and our general Gulf Coast experience. The CPT data were processed using our in-house cone test data interpretation program. The correlations used to obtain material descriptions and soil behavior types are based on Robertson, P. K., and Campanella, R. G.[1], and their correlation chart is presented on Plate 1 of this report and in Volumes Ia through Ic. Relative density and friction angles are based on correlations presented by Schmertmann, J. H.[2] Undrained shear strengths were initially determined by using a cone factor of 13.5 (which is applied to the tip resistance value corrected for effective overburden pressure). Typically cone factors range between about 10 and 24, and are usually based on local experience. For our engineering analyses, we used a cone factor more on the order of 20. This use of this greater value, which results in lower shear strength interpretation, is based on results of our previous investigation on Isles Dernieres and the lack of additional site-specific shear strength data.

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(1) Robertson, P.K. and Campanella, R.G. (1984), Guidelines For Use and Interpretation of The Electric Cone Penetration Test, Soil Mechanics Series No. 69, Department of Civil Engineering, The University of British Columbia.

(2) Schmertmann, J.H., (1978), Guidelines for Cone Penetration Test, Performance and Design, Federal Highway Administration, Report FHWA-TS-78-209.

# LABORATORY TESTING

## General

Laboratory tests were performed on the near-surface soil samples that were collected in bags at each cone location. Primarily, we were concerned with evaluating classification properties and remolded shear strength.

## Classification Testing

Test Methods. Our laboratory testing program designed for this project consisted of water content, liquid and plastic limits (Atterberg limits), and mechanical sieve analysis tests. These tests were performed in general accordance with the following current ASTM standards.

| Test | ASTM Designation |
|---|---|
| Water content | D 2216 |
| Liquid limit | D 4318, Method C |
| Plastic limit | D 4318, Method C |
| Mechanical sieve analysis | D 422 |

In most cases, samples were dried in a standard oven having a temperature of 110 $\pm$ 5°C. Those samples visually observed to have a significant amount of organic material were dried in an oven with a temperature of 60 $\pm$ 5°C.

## Shear Strength Measurement

Test Method. The remolded (disturbed) shear strength of cohesive soils was determined by performing remolded miniature vane tests. In this test, a small, four-bladed vane is inserted into a remolded cohesive soil specimen. Torque is applied through a calibrated spring until soil shear failure occurs. The shear strength is determined by multiplying the rotation, in degrees, by the spring constant. For each test specimen, the water content is also determined.

## Data Presentation

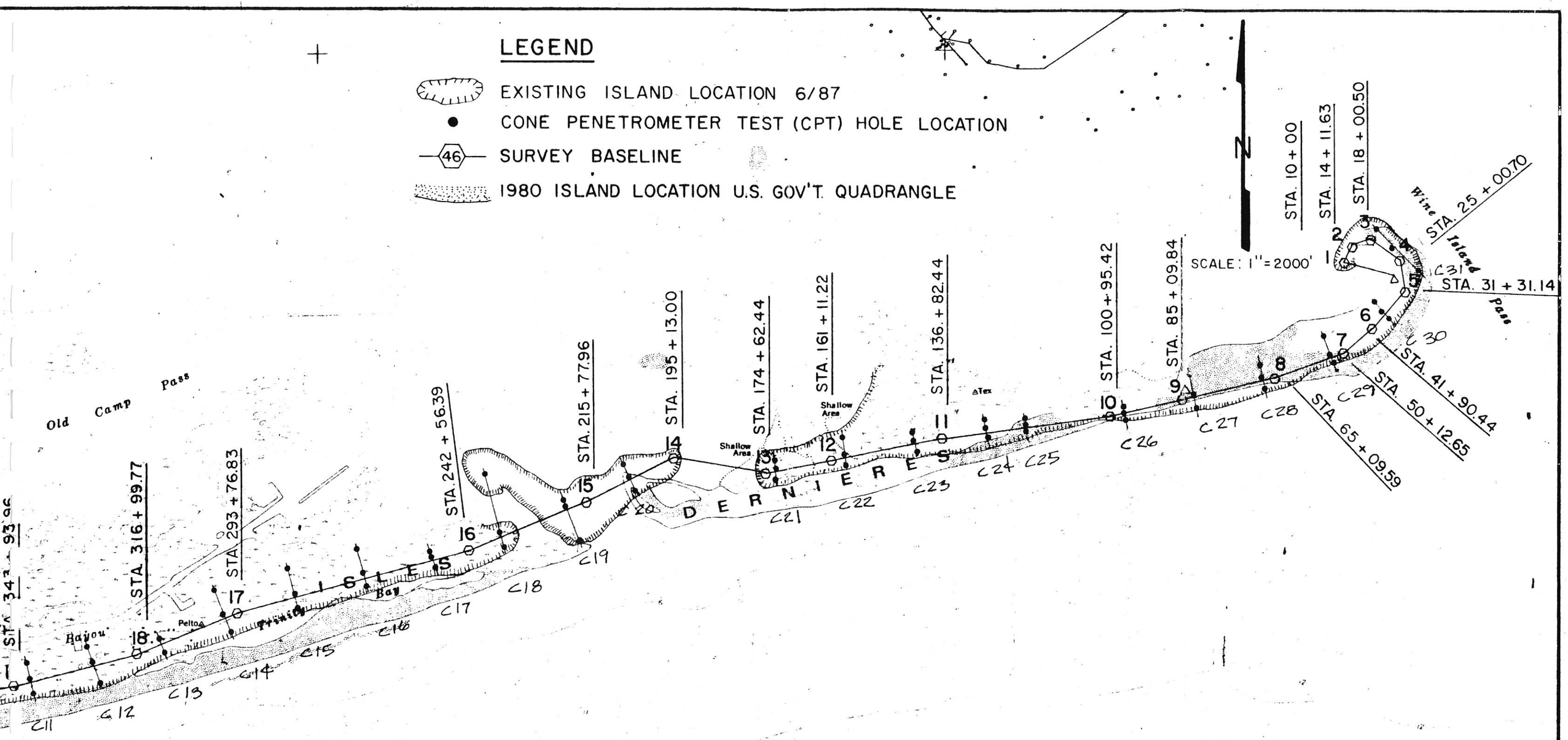
Data from the above referenced tests are presented in Volumes Ia through Ic. Water contents, liquid and plastic limits, remolded shear strengths, and percent passing the No. 200 sieve (from the grain size tests) are tabulated on the Summary of Test Results included in each of the above referenced volumes. Mechanical grain size results are presented in tabular

form and include key coastal and geotechnical grain size parameters, both in phi units and in millimeters. This format for data presentation was discussed with the design team members and was selected because it facilitated the use of the data. Although we have presented several important parameters regarding grain size characteristics, statistical evaluation of these parameters is beyond our scope of work and we understand this aspect of the data interpretation is being performed by The Traverse Group.

# ILLUSTRATIONS

## LEGEND

- EXISTING ISLAND LOCATION 6/87
- CONE PENETROMETER TEST (CPT) HOLE LOCATION
- (46) SURVEY BASELINE
- 1980 ISLAND LOCATION U.S. GOV'T. QUADRANGLE




**Gulf of Mexico**

EASTERN ISLAND SEGMENT

S. P. 750-55-01
BARRIER ISLAND STABILIZATION PROJECT
TERREBONNE PARISH, LA.
ONSHORE CPT HOLE LOCATION
DRAWING BY: MCCLELLAND ENGINEERS, INC.

## LEGEND

- EXISTING ISLAND LOCATION 6/8
- CONE PENETROMETER TEST (CP
- 46 SURVEY BASELINE
- 1980 ISLAND LOCATION U.S. GOV'T.

Lake Pelto

Old Camp Pass

STA. 489 + 11.99

STA. 473 + 53.84

STA. 462 + 03.35

STA. 442 + 89.07

STA. 421 + 12.07

STA. 393 + 92.33

STA. 368 + 64.92

STA. 343 + 93.96

STA. 316 + 99.77

STA. 293 + 76.83

STA. 242 + 56.39

STA. 215 + 77.96

STA. 195 + 13.00

STA. 174 + 62.44

STA. 161 + 11.22

26 25 24 23 22 21 20 19 18 17 16 15 14

C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15 C16 C17 C18 C19 C20 C21

Trinity Bayou

Pelto Bay

Shallow Area

Gulf of Mexico

CAILLOU BAY

Pass Wilson

BAY ROUND

CAILLOU BOCA

N

SCALE: 1" = 2000'

STA. 840 + 63.60

STA. 791 + 93.14

STA. 763 + 71.36

STA. 748 + 66.15

STA. 739 + 53.99

STA. 720 + 10.62

STA. 682 + 69.76

STA. 668 + 56.73

STA. 648 + 38.21

STA. 625 + 49.82

STA. 602 + 26.72

STA. 582 + 76.98

38 37 36 35 34 33 32 31 30 29 28 27

C45 C44 C43 C42 C41 C40 C39 C38 C37 C36 C35 C34 C33

Light

BM 2

ISLAND 1 ISLAND 2 ISLAND 3 ISLAND 4

COUPE NOUVELLE

Whiskey Island

## LEGEND

- EXISTING ISLAND LOCATION 6/87
- CONE PENETROMETER TEST (CPT) HOLE LOCATION
- (46) SURVEY BASELINE
- 1980 ISLAND LOCATION U.S. GOV'T. QUADRANGLE

CENTRAL ISLAND SEGMENT

S. P. 750-55-01
BARRIER ISLAND STABILIZATION PROJECT
TERREBONNE PARISH, LA.
ONSHORE CPT HOLE LOCATION
DRAWING BY: MCCLELLAND ENGINEERS, INC.

## LEGEND

EXISTING ISLAND LOCATION 6/87

CONE PENETROMETER TEST (CPT) HOLE LOCATION

SURVEY BASELINE

1980 ISLAND LOCATION U.S. GOV'T. QUADRANGLE

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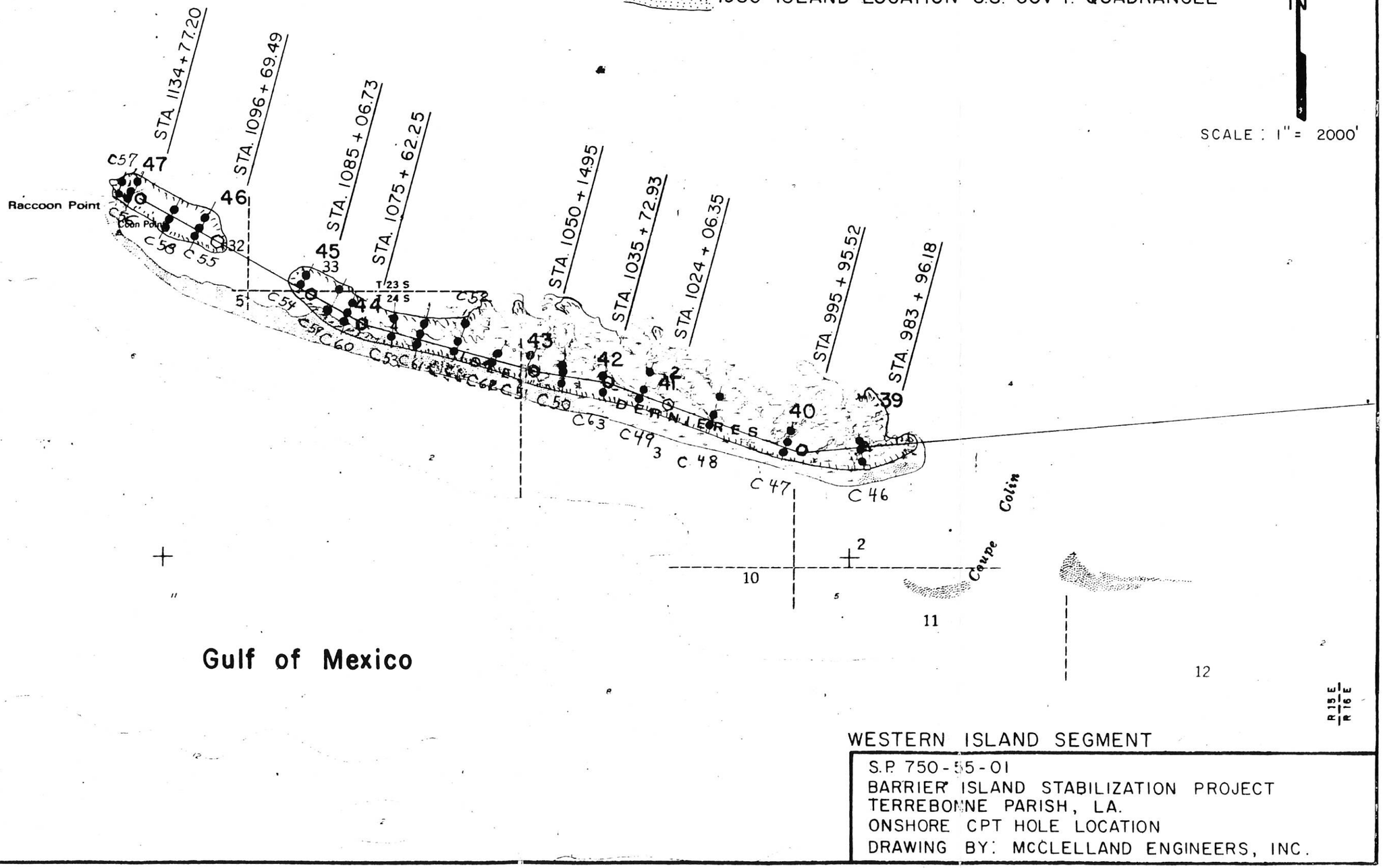
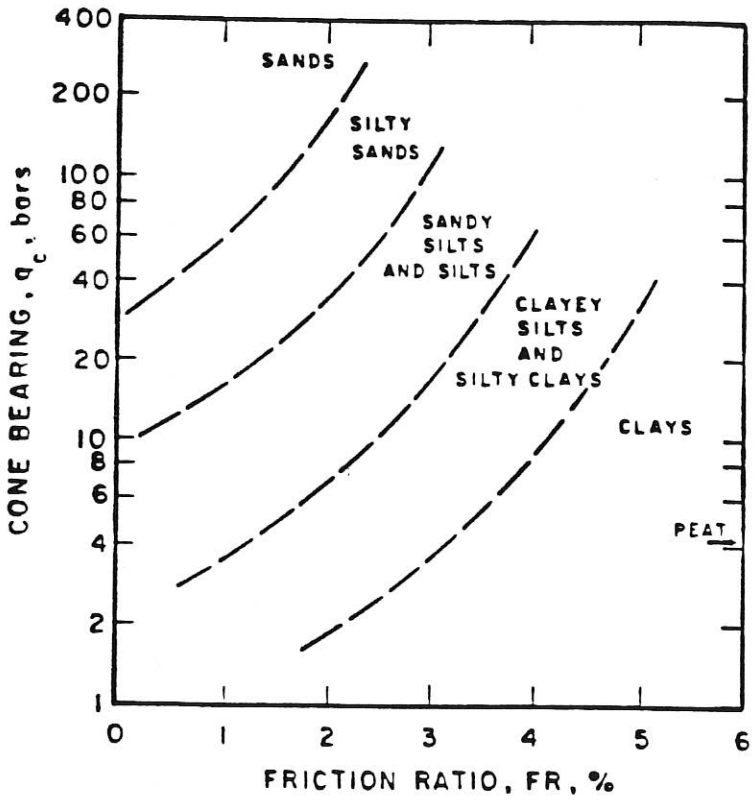
SCALE : 1" = 2000'




WESTERN ISLAND SEGMENT

S.P. 750-55-01
BARRIER ISLAND STABILIZATION PROJECT
TERREBONNE PARISH, LA.
ONSHORE CPT HOLE LOCATION
DRAWING BY: McCLELLAND ENGINEERS, INC.

# INTERPRETATION OF CONE PENETROMETER DATA




Notes:

1) Cone penetrometer testing is a proven and widely accepted site investigation method that requires skill and judgement in the interpretation of the test results to provide a geotechnical characterization of the investigated soils and a development of their engineering properties.

2) Soil descriptions are based on correlations of tip resistance, $q_c$; and the friction ratio, FR, which is the ratio of the unit sleeve friction, $f_s$ to $q_c$.

3) Correlations used for interpretation include: 1) Robertson, P.K., and Campanella, R.G., and 2) Schmertmann, J.H.

4) 1 bar is about 1 tsf.